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ON SOME ENTOMOSTRACA OF LAKE MICHIGAN AND ADJACENT WATERS.

BY S. A. FORBES.

ONE cannot go far in the study of the system of organic life which prevails in a stream or lake, without being made aware of the important part played therein by the neglected but interesting group of the smaller crustaceans. They occupy a central position not only in the classification of aquatic animals, but also in the complicated network of physiological relations by which the living forms of a body of water are held together as an organized society. Feeding, themselves, upon the lowest and smallest of plants and animals, they furnish food in turn to a great variety of the higher animals, and even to some plants.[1]

The fisherman who toils at his nets, the sportsman in pursuit of health and recreation, rarely reflect, even if they know, that their amusements and their labors depend strictly upon these humble creatures, of whose very existence, indeed, many of them are unaware; and yet there is ample evidence that, with few and unimportant exceptions, all young fishes, of our fresh waters at least, live for a time almost wholly upon entomostraca.[2] If deprived of this resource for the nourishment of their young, fishes would be reduced to an insignificant remnant of their present numbers.

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[1] In ten "bladders" of *Utricularia vulgaris*, taken at random, I found ninety-three animals, either entire or in recognizable fragments, and representing at least twenty-eight species. Seventy-six of the animals found were Entomostraca, and belonged to twenty species. Nearly three-fourths of both individuals and species were Cladocera. Just one-third of all the animals found in these bladders belonged to the single species *Acroperus leucocephalus* Koch.

[2] On the Food of Young Fishes. By S. A. Forbes. Illinois State Laboratory of Natural History, Bulletin No. 3, November, 1880, pp. 66–79.

On the First Food of the Whitefish. By S. A. Forbes, Normal, Ill. The *American Field*, Vol. XVII, No. 11, p. 171, March 11, 1882.

Immense quantities of them are also taken by adult fishes, especially in early spring, and some of the largest species make them a principal dependence. The shovel fish (Polyodon) of our great central rivers—a giant among inland fishes—engulfs untold myriads of them at a meal—thus performing in fresh water the functions of the whale in the great seas. In the lakes of Europe they are the main food resource of several deep water salmonoids, while in our own great lakes, clouds of the higher crustaceans (Mysis) live wholly at their expense; and these Mysidæ, again, contribute largely to the maintenance of the whitefish and black-fin, and other important species. Some insect larvæ likewise prey upon them; and amphipod crustaceans, while they seem to feed chiefly upon vegetable structures of one sort or another, certainly sometimes attack and devour entomostraca with a surprising ferocity. Mollusca, one would say, could afford to be indifferent to them, since they neither eat them nor are eaten by them, nor seem to come in contact with them anywhere, through any of their habits or necessities. But for this very reason these two classes afford an excellent illustration of the stringent system of reactions by which an assemblage of even the most diverse and seemingly independent organisms is held together. To say nothing of the fact that both groups feed to a considerable extent upon the same kinds of food, and thus probably limit each other's multiplication, in some degree, the further fact that vast quantities of both are destroyed by fishes, brings them into a mutually hostile relation. If there were no entomostraca for young fishes to eat, there would be very few fishes indeed to feed upon mollusca, and that class would flourish almost without restraint; while, on the other hand, if there were no mollusca for the support of adult fishes, entomostraca would be relieved from a considerable part of the drain upon their numbers, and would multiply accordingly.

It is through their intervention that fishes and certain carnivorous plants are brought into apparent competition. The number of entomostraca and minute insect larvæ destroyed by the bladder-wort in some situations where the plant fills acres of the water, must be prodigious, taking the season through; and it is not impossible that the food supply of young fishes is sometimes thereby materially diminished.

In short, it would be difficult to mention a single group of aquatic or semi-aquatic animals or plants, whose interests are not affected, immediately or remotely, by these little animals.

But they have other claims upon our attention besides their importance in the general system of aquatic life. To the student of classification, they offer a fresh and inviting field of original work; the physiologist and the histologist may examine here the animal organs and tissues reduced almost to their lowest and simplest terms, and yet easily studied in detail, while they still form living parts of living organisms; and those attracted by natural beauty (as who is not?) will find few lovelier objects for the microscope, or more admirable illustrations of the play of life than these exquisite, crystalline specks, each comprising within its minute anatomy a system of organs and structures which for complexity and for perfection of detail, would scarcely discredit a butterfly or a fish.

I know of but one contribution to an exact knowledge of the Entomostraca of Lake Michigan—a brief paper by Professor E. A. Birge, containing a list of nine species of Cladocera found in the Chicago water supply,[1] with a description of *Latona setifera* O. F. M.; and I have seen nothing upon those of any other of the great lakes, except the notes on a few Cladocera published by Professor S. I. Smith in his paper on the invertebrate animals of Lake Superior.[2]

On the smaller crustacea of the region adjacent to the lakes, we have the valuable "Notes on Cladocera,"[3] by Professor Birge, and a paper by the writer on the Crustacea of Illinois.[4]

The lake material upon which the present paper is based, was obtained chiefly by the towing-net and dredge in Grand Traverse bay, in the north-eastern part of Lake Michigan, and in the south end of the lake off Chicago and Racine. Several of the lacustrine species had been previously received from Mr. B. W. Thomas and Mr. Chas. S. Fellows, of Chicago, by whom they had been strained from the Chicago water supply.

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[1] Notes on Crustacea in Chicago Water Supply, with remarks on the Formation of the Carapace. By E. A. Birge, Professor of Zoology, University of Wisconsin, Madison, Wis. The Chicago *Medical Journal and Examiner*, Vol. XIV, No. 6, Dec., 1881, pp. 584–590, Pl. I and II.

[2] Sketch of the Invertebrate Fauna of Lake Superior. By Sidney I. Smith, United States Commissioner of Fish and Fisheries. Part II. Report of the Commissioner for 1872 and 1873, pp. 690–707.

[3] Transactions of the Wisconsin Academy of Sciences, Arts and Letters, Vol. IV, 1876–77, Madison, Wis., 1879, pp. 77–110, and Pl. I and II.

[4] Bulletin of the Illinois Museum of Natural History, No. 1, December, 1876, pp. 3–25, and Pl. I.

A few additional species from the lakes and pools of Central and Northern Illinois, are described in the appendix to this paper, one of which occurs also in Southern Massachusetts, and probably throughout the country intervening.

One of the most interesting species was obtained in considerable numbers in Grand Traverse bay, associated with the ordinary forms of the lake, nearly all of which were abundant there in October, 1881. It is a copepod of the family Calanidæ, representing a new genus and species, for which the name *Epischura lacustris* is proposed (Pl. IX Fig. 8, and Pl. VIII Figs. 15, 16, 21–23 and 25–27).

The family is easily distinguished from Cyclopidæ and Harpactidæ, to which most of our other fresh-water species belong, by the elongate anterior antennæ of 23–25 articles, by the (usually) two-branched antennulæ and mandibular palpi, by the wide difference in size between the abdomen and thorax, and by the fact that in the male only one antenna is converted into a clasping organ. Epischura is colorless in autumn, although possibly red in spring, .063 in. long by .015 in. wide, and distinguished in both sexes by what seems at first a deformity of the abdomen. On closer inspection it is seen that in the male the last three segments of this region are laterally produced into a grasping organ of peculiar construction, and that the whole abdomen is thus distorted and rendered unsymmetrical. The lateral processes of the first and second segments evidently act against each other as a powerful pair of nippers, while the third, bearing upon the same side a stout toothed plate, must greatly increase the security of the grasp, when brought into play by the strong muscles of the abdomen. A fourth process extending forward from near the base of the right ramus of the furca, also contributes to the formation of this organ. A steel-trap attachment to the tail of an alligator would very well illustrate the vigorous embrace of this little crustacean. Besides this, the right antenna is thickened and hinged as a clasper, and the last pair of legs is also converted into a complicated apparatus of claws and forceps. In the adult female the abdomen is usually bent outward to the left, to leave space for a finger-like process which arises at the hind end of the ovisac and curves upward beside the second segment. This is the spermatophore, the neck of which is firmly cemented to the under side of the abdomen. In this sex the legs of the fifth pair are extremely simple and rather small. They are not branched like the other legs, and are without the delicate and beautiful fringes of feathery hairs with which the swimming appendages are provided, but each consists of a single flat, three-jointed plate, with five spreading spines at and near its tip. The swimming legs of both male and female are peculiar in the fact that the inner branch of all the pairs is reduced to a single joint. The affinities of this genus are with Heterocope Sars, found in the lakes of Scandinavia, Switzerland and Upper Italy, and probably in other parts of Europe also; but the modification of the abdomen as a prehensile organ is a new idea among Copepoda. Mutilated specimens of the female of this species have been taken by Mr. Thomas from the water supply of Chicago; I also found the species common in Geneva lake, in Southern Wisconsin, in October, 1881.

Another beautiful member of this family, occurring abundantly everywhere in the lake and at all seasons of the year, is closely related to the *Diaptomus gracilis* of Europe; but a careful study of it during successive seasons, and a comparison with the original description of Sars and with the descriptions and plates of *D. gracilis* published by Gruber in 1878, have satisfied me that our species is distinct, and I therefore propose for it the name of *Diaptomus sicilis* (Pl. VIII, Figs. 9 and 20). It is the most slender and elegant of our Calanidæ, usually colorless and transparent, but sometimes crimson in spring. The antennæ are long and weak, reaching beyond the tip of the abdomen, and are provided with hairs of unusual length, that on the ninth joint, for example, reaching beyond the fourteenth. It is in the fifth pair of the legs of both male and female that we find the best distinguishing characters in this family—and here the clearest distinctions from *Diaptomus gracilis* occur. In the male both pairs are two-branched. The last joint of the right leg forms a slender, sickle-shaped hook, which is regularly curved from base to apex, while the outer branch of the left leg of this pair is two-jointed, with a pubescent, rounded extremity, bearing two short diverging claws.

EXPLANATION OF PLATE VIII.

FIG. 1.—Diaptomus sanguineus, ♀, × 42.
" 2.—Dorsal outline of the same.
" 3.—Diaptomus sanguineus, ♂, geniculate antenna, × 50.
" 4.— " " ♂, right leg of fifth pair, × 67.
" 5.— " " ♂, left " " × 70.
" 6.— " " ♀, leg of fifth pair.
" 7.— " " second maxilliped, × 63.
" 8.— " stagnalis, antennula, × 48.
" 9.— " sicilis, ♂ fifth pair of legs, × 160.
" 10.— " stagnalis, ♂, fifth pair of legs, × 48.
" 11.— " " ♂, geniculate antenna, × 22.
" 12.— " " ♂, left antenna, × 22.
" 13.— " sanguineus, mandible, × 160.
" 14.— " stagnalis, ♀, leg of fifth pair, × 86.
" 15.—Epischura lacustris, ♀, fifth pair of legs, × 88.
" 16.— " " ♀, side view of abdomen, × 17.
" 17.—Diaptomus leptopus, ♀, leg of fifth pair, × 66.
" 18.— " " ♂, right leg of fifth pair, × 66.
" 19.— " " ♂, left " " × 66.
" 20.— " sicilis, ♀, fifth pair of legs, × 160.
" 21.—Epischura lacustris, mandible and palpus.
" 22.— " " blade of mandible.
" 23.— " " ♀, abdomen and furca from above, × 48.
" 24.—Osphranticum labronectum, first maxilliped, × 180.
" 25.—Epischura lacustris, ♂, fifth pair of legs, 70.
" 26.— " " second maxilliped, × 88.
" 27.— " " leg of first pair, × 70.
" 28.—Osphranticum labronectum, ♀, leg of fifth pair, × 70.
" 29.— " " ♂, fifth pair of legs, × 70.

(To be continued.)

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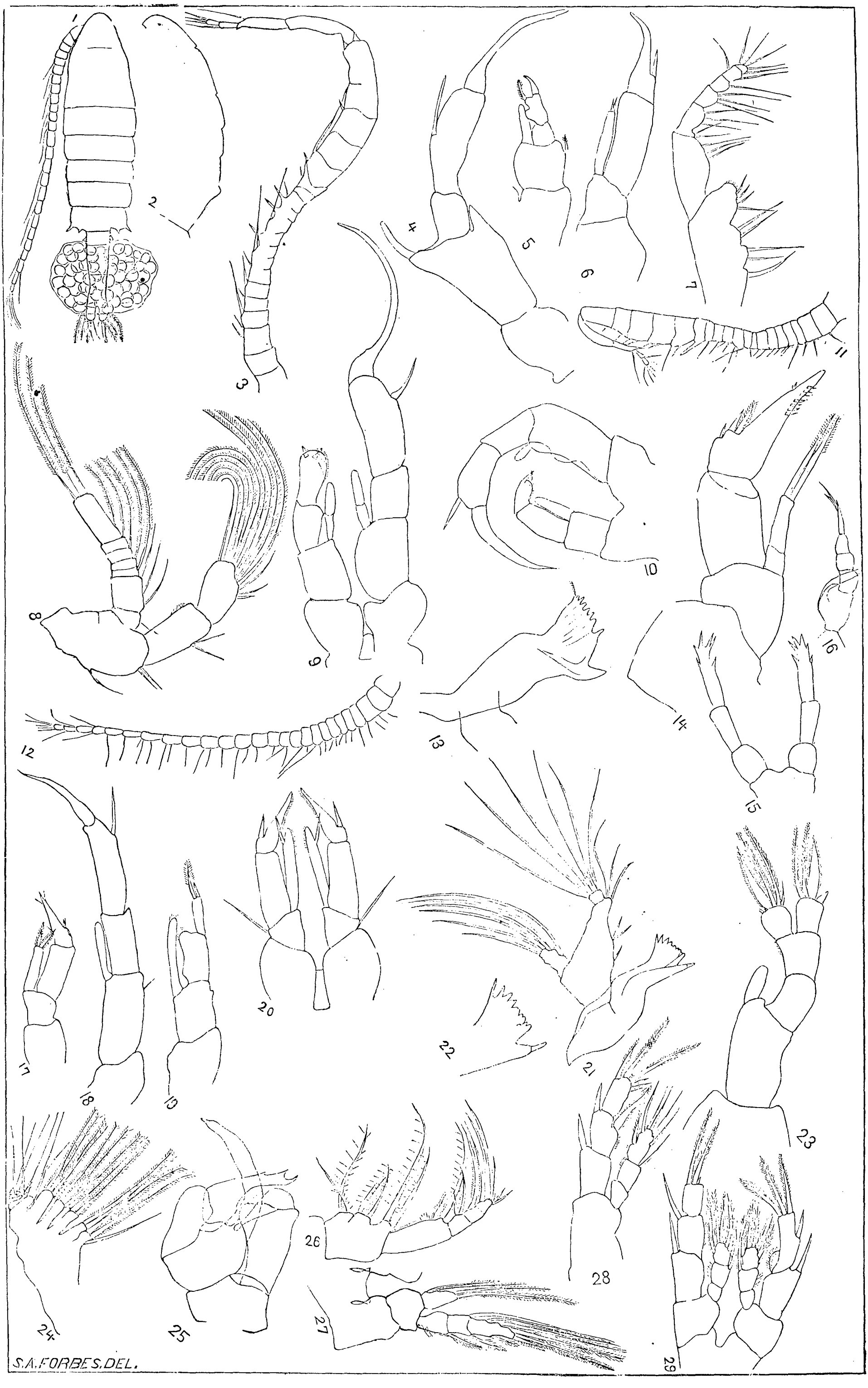
THE LOESS OF NORTH AMERICA.

BY R. ELLSWORTH CALL.

(Continued from May number.)

Physical Geography of the Loess Era.—The Champlain epoch, to which the loess belongs, was characterized by general continental depression, which lessened the area of the land and increased the average temperature. Such a depression was followed by extensive encroachment of the sea and its arms upon the land, the effects of which would be greatest in the great central basin of the continent. Hence there was a backing up of all the streams and a general sluggishness or complete loss of their currents in the lower portions of their valleys. At their sources extensive denudation was in progress, and the material thus derived

PLATE VIII.


S.A. FORBES, DEL.